to determine whether any particular phase of the temperature data is best adapted to indicate the degree of abnormality of the season. As a result of these trials it was found that the order of magnitude of the abnormality was practically the same whatever method was used; hence in the interest of simplicity the method of departures of the monthly means from normal has been selected. This method is, in short, as follows: If the monthly departures of December, January, and February be expressed by a+b+c, then the algebraic sum of these departures divided by 3 will give a value that may be considered as expressing with fair accuracy the temperature abnormality of the winter. A concrete illustration follows. Winter of 1924–25 at Washington, D. C., temperature departure of the three winter months, Dec. −0.2, Jan. −0.4; Feb. +7.8; sum, +7.2, which divided by 3 gives a departure for the winter of plus 2.4 F.

The abnormalities for five stations, San Francisco, Salt Lake City, Denver, St. Louis, and Washington, have been computed for each winter of the record from about 1871 to 1923. The individual seasonal departures may be arranged in a descending series from the coldest winter of record to those that may be classed as average or moderately cold. This has been done, although the table is not reproduced. It shows that extremes of cold weather are rarely, if ever, so widespread as to embrace the greater part of the area of continental United States, but rather the tendency is for the extreme cold to be localized in a relatively small area; hence the table does not answer the question, "What was the coldest winter in the United States as a whole during the last 50-odd years?" The magnitude of the temperature departure depends, of course, upon the continentality of the different parts of the area; for example, the northern boundary States of Montana, North Dakota, and Minnesota, being remote from the oceans and in close contact with regions to the northward having severe winters, show the greatest variations from the monthly means, and the magnitude of these variations diminishes with distance to the south and toward both the Atlantic and Pacific Oceans. There is, moreover, a tendency toward a reversal of the sense of the temperature departure between the Pacific slope States and the region east of the Rocky Mountains. The second coldest winter at San Francisco, 1889–90, was the warmest winter in the 50-odd years east of the Mississippi. There is also some indication of a west-to-east movement of great abnormalities, as, for example, the coldest winter at Salt Lake City, 1916–17, was followed by the very cold winter of 1917–18 east of the Mississippi. Other interesting comparisons are possible. The abnormalities of individual seasons for, say, 50 years also afford some basis of classification. Two tentative classifications, the first for the Pacific coast, the second for the interior, are presented below.

Classification of winters

	(a) Pacific	(b) Interior
Average winter, limits between	+0.5 and −0.5	+1.0 and −1.0.
Moderately warm	+0.6 and +1.5	+1.1 and +3.0.
Warm	+1.6 and +2.5	+3.1 and +5.0.
Very warm	+2.6 up	+5.1 up.
Moderately cold, limits between	−0.5 and −1.5	−1.1 and −3.0.
Cold	−1.6 and −2.5	−3.1 and −5.0.
Very cold	−2.6 up	−5.1 up.

An example of the classification of winters according to the limits above given is given in Table 1.

TABLE 1.—*Abnormal winters at San Francisco, Salt Lake City, Denver, St. Louis, and Washington, classed as average, moderately cold, cold, very cold, etc.*

	San Francisco		Salt Lake City		Denver		St. Louis		Washington	
	Years	Departures	Years	Departures	Years	Departures	Years	Departures	Years	Departures
Average	1891–92	±0.0	1919–20	−0.7	1879–80	−0.8	1914–15	−1.0	1882–83	−0.8
Moderately cold	1897–98	−1.2	1887–88	−1.5	1876–77	−2.7	1919–20	−3.0	1884–85	−2.6
Cold	1882–83	−1.7	1892–93	−3.7	1878–79	−4.0	1901–02	−4.3	1892–93	−3.5
Very cold	1909–10	−2.5	1916–17	−5.8	1898–99	−7.3	1917–18	−6.9	1904–5	−5.5
Moderately warm	1888–89	+1.3	1899–00	+1.4	1889–90	+2.3	1891–92	+2.3	1895–96	+1.8
Warm	1917–18	+1.8	1920–21	+3.1	1895–96	+4.5	1918–19	+5.2	1890–91	+3.2
Very warm	1876–77	+3.2	1906–07	+5.7	1906–07	+5.8	1889–90	+9.1	1889–90	+9.8

A REMARKABLE TWO-THEODOLITE PILOT-BALLOON SERIES

By WILLIAM C. HAINES

[U. S. Weather Bureau, Washington, D. C.]

An interesting series of two-theodolite pilot-balloon observations was made at the aerological station at Broken Arrow, Okla., on October 14, 1924. The series consists of five soundings, all of which reached altitudes of 11,000 to 14,000 meters (roughly 7 to 9 miles) above the surface. Wind velocity and direction graphs of four of the five soundings are reproduced in Figure 1. The observations were made at 7:03a, 10:05a, 1:23p, 3:02p, and 4:57p. The graph of the observation taken at 4:57p, is omitted from the accompanying figure, but it is similar to the other four in all essential characteristics. Since all of these observations were made with two theodolites, their accuracy can not be questioned.

The following are some of the interesting features of the observations: Light winds averaging only 4 or 5 meters per second (about 10 miles per hour) prevailed up to approximately 7,000 meters. Above this altitude the wind increased very rapidly, attaining velocities as great as 50 meters per second (112 miles per hour). Apparently above 13,000 meters the velocity decreased as shown by the highest graph. The wind direction above 4,000 or 5,000 meters was from west to northwest and remained practically constant throughout the day. Below this altitude the direction was variable, finally shifting to southeast from the surface up to 3,000 meters in the late afternoon.

Another interesting feature of the series is the persistency throughout the day of the small irregularities in wind velocity. Note the increases in velocity marked "a" and "b," which are evident in all four graphs. They are also just as pronounced in the fifth graph, which is not reproduced.

The weather map on the morning of the 14th showed a flat HIGH central over the upper Mississippi Valley, with a weak trough of low pressure extending north and south across the country just east of the Rocky Mountains. The high-pressure area moved eastward and at 8 p. m. was central over the Upper Lake region.

It is probable that all of these soundings penetrated the stratosphere, although there is nothing to bear out this statement except the height attained and the decrease in velocity above 13,000 meters. High velocities are not always present at great altitudes. Many soundings that reach altitudes from 10,000 to 15,000 meters show comparatively low wind velocities from the surface up. Very often the wind velocity at high levels appears to bear no relation to the surface condition shown by the current weather map.

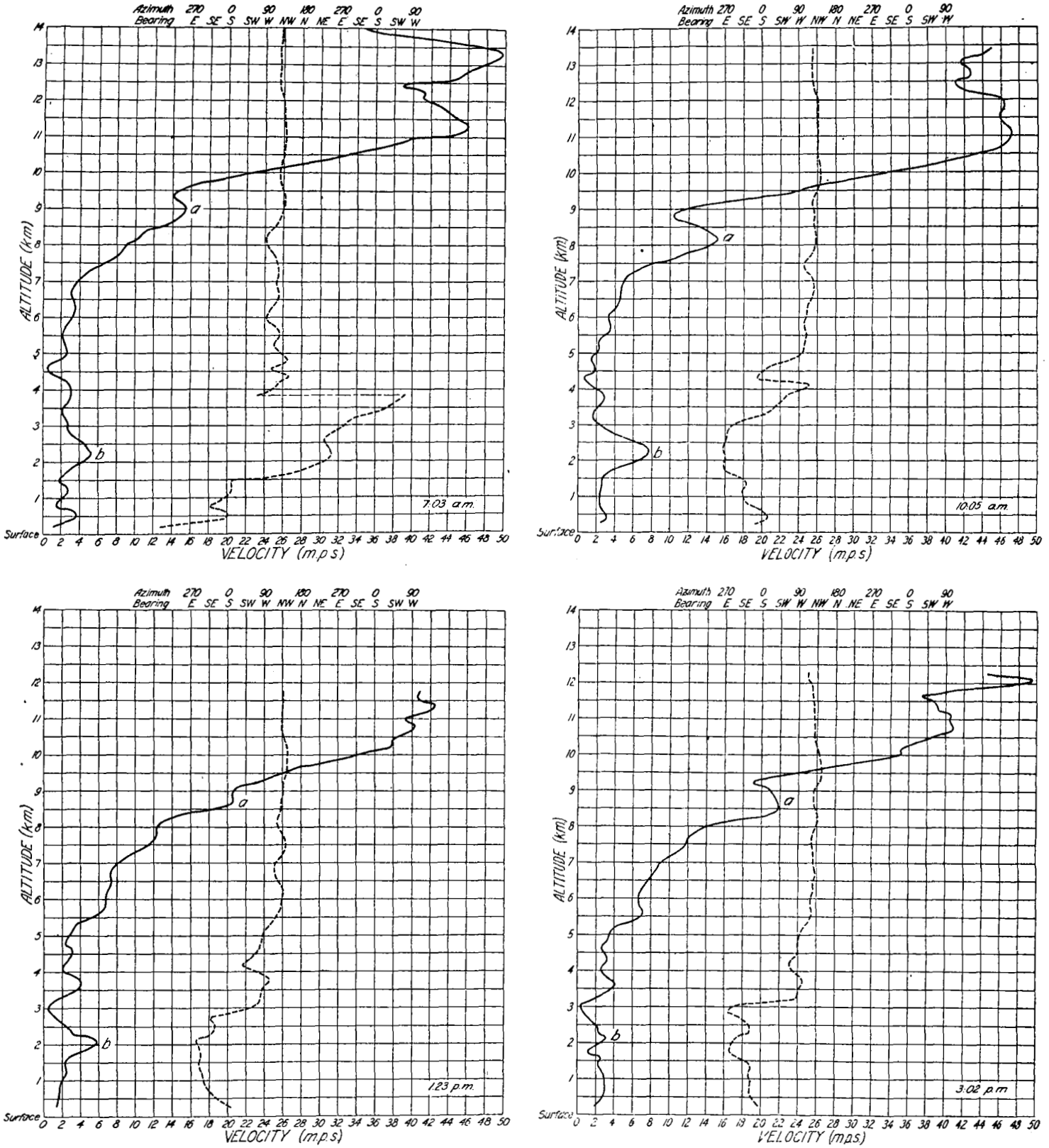

FIG. 1.—Wind direction and velocity, (m. p. s.,) in the free air at Broken Arrow, Okla., on October 14, 1924. Broken lines represent direction, with legend at top, and solid lines, velocity, with legend at bottom. Altitude in kilometers is indicated in the margin. The time of the observations on which the curves are based is indicated on the graph.

In single-theodolite work, when a very rapid increase in velocity is encountered, the question arises as to its reality, since it may be explained by faulty ascensional rate of the ballon caused by leaking. In the earlier years of single-theodolite work there was a strong tendency to question the accuracy of what appeared to be an abnormal record, such as a very rapid increase in velocity. In the past three or four years, however, numerous instances in which records like those shown in Figure 1 have been authenticated by the two-theodolite method, together with the now well-known rarity with which leaks develop in balloons, lead to the conclusion that single-theodolite results are dependable, providing reasonable care is taken in preparing the balloon, setting up the theodolite, and reading the angles.

FRUIT-SPRAY AND HARVEST-WEATHER FORECAST WORK OF THE WEATHER BUREAU IN NEW YORK STATE[1]

By E. B. CALVERT

The subject of this paper involves two distinct, though closely related, projects. The Weather Bureau portion of the work is performed at Ithaca, N. Y., and the cooperative features are handled by the officials of the State College of Agriculture and State Extension Service at Ithaca.

The fruit-spray forecast service, principally for apple orchardists in 10 counties near Lake Ontario, begins early in April and extends into the latter part of June.

The harvest-weather forecast work starts in the latter part of June and extends through August, although there is demand and justification for beginning it earlier and terminating it a few weeks later.

THE FRUIT-SPRAY FORECAST SERVICE

This service was begun in 1919 to furnish specialized information as to the coming of rains. While the apple growers suffer serious loss from frost on an average of less than one year in ten, scab is an almost ever-present menace. The spores of this fungus come into activity when moistened, and unless killed by spraying may infect a tree within less than 24 hours. The problem is to apply spray containing poison ingredients just before rains or a prolonged period of moist, misty weather, because the poisons must be present when the spores start to grow. Unless rains or misty weather occur within about three days after spray is applied, the effect of the poison is minimized or lost altogether, but if rains occur and spray has not been applied a season's profit may be turned to loss.

When it is known that about 12,000 commercial apple orchards in 9 counties are equipped for spraying; that, working the limit of daylight hours, two to three days are required for spraying many of the larger orchards; that at least three applications are made in a season; that the total cost during a season for materials and labor alone represents an expenditure of over $3,500,000; and the returns from sales of fruit from properly sprayed trees is often in excess of $100 per acre over that from infected trees, the great responsibility of the forecaster for issuing accurate and timely weather forecasts becomes apparent.

Plant pathologists and entomologists are on duty in nearly all the apple-growing counties during the spraying season for the purpose of watching swelling, budding, and blooming developments and determing when the various orchards are in the proper stages for spraying, This varies according to nearness to the lake, topography, and other conditions. Prior to 1919 these men undertook to interpret the regular weather forecasts and to give spraying advices accordingly. It was apparent, however, that these forecasts should be extended to cover two or three days in order that there might be ample time for applying sprays in the large orchards.

Accordingly, a meteorologist was assigned to the work for the first season, with headquarters at Rochester. Successful demonstrations of the feasibleness of the plan were made. For two or three seasons the State and local extension and farm bureau services met a fair portion of the expenses, it being quite impossible for the Weather Bureau to withdraw enough funds from other activities to carry on the work. Concerted effort on the part of the orchard interests finally secured a small appropriation for the present fiscal year, and the project is now for the first time on what may be considered a permanent basis.

The Weather Bureau portion of the work is conducted from the Weather Bureau office at Cornell University by Mr. J. C. Fisher and his assistant, Mr. C. E. Lamoreaux, under the supervision of Dr. W. M. Wilson, official in charge at Ithaca. A telegram is sent each night during the spraying season from Washington giving the views of the Washington forecaster as to the character of weather to be expected in New York orchard districts for as long a period in advance as the conditions shown on the weather map justify. Mr. Fisher then prepares amplified forecasts, based on the message received from Washington and on his own intimate knowledge of the areas for which the forecasts are made. These forecasts are issued every night by telegraph or telephone to the one or more pathologists and entomologists who are field leaders in the various counties. A telephone relay system is organized in each county, through which all the orchardists whose trees are in a condition for spraying are notified by the field leaders before the following morning.

Demands for similar service have been received from the apple-growing districts of Pennsylvania, Maryland, West Virginia, and Virginia. Some service has been given to these districts, but in no such organized way as in New York. Plans are under way, however, for organizing and extending the work in these States along lines similar to those in New York.

THE HARVEST-WEATHER FORECAST SERVICE

This service, like the fruit-spray service, was conducted as an experiment and demonstration for two or three years. It is really an outgrowth of the other. Credit for its inception belongs to Dr. Wilford M. Wilson. He ascertained that the forecasts made for the benefit of orchardists were also being used by farmers of those sections as a guide in their farming operations and especially in early harvesting. Therefore in the summer of 1921 a direct service to farmers was inaugurated in a few counties for their guidance in the harvesting of hay, oats, wheat, and other crops. The forecasts were prepared and the work done by Mr. M. R. Sanford, in charge of the Weather Bureau office at Syracuse. He performed all the duties connected therewith until this last season, when for administrative reasons it was transferred to Ithaca. It is due largely to Mr. Sanford's energy and ability that the demonstration was so highly successful.

[1] (Read at the meeting of the American Meteorological Society, Jan. 2, 1925, Washington, D. C. The following text is condensed from the original.—*B. M. W.*)